CONSTRUCTION PERMIT

OFFICE OF AIR MANAGEMENT

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
100 North Senate
P.O. Box 6015
Indianapolis, Indiana 46206-6015

EXHIBIT 1

ELI LILLY AND COMPANY
1555 S. KENTUCKY AVENUE
INDIANAPOLIS, INDIANA

is hereby authorized to construct

two pilot plant modules E and F, and portable equipment associated with the pilot plant. Furthermore, pursuant to 326 IAC 8-1-5, this Construction Permit will authorize Eli Lilly and Company to comply with 326 IAC 8-5-3 through alternative control requirements on the new and existing equipment in the pilot plant in Building 110.

NEW EQUIPMENT:

	500 Gallons Glass Lined Reactor	D/E
	300 Gallons Glass Lined Reactor	D/E
	200 Gallons Hastelloy Reactor	D/E
	100 Gallons Hastelloy Reactor	D/E
	100 Gallons Glass Lined Removable Reactor	D/E
	100 Gallons Glass Lined Removable Reactor	D/E

(Continued)

THIS PERMIT IS ISSUED UNDER PROVISIONS OF 326 IAC 2-1 AND 40 CFR 52.780, WITH CONDITIONS LISTED ON THE ATTACHED PAGES.

THIS PERMIT SUPERSEDES ALL PREVIOUS PERMITS ISSUED BY INDIANAPOLIS AIR POLLUTION CONTROL SECTION ASSOCIATED WITH THE EQUIPMENT COVERED BY THIS PERMIT.

Identification No. CP 097-3341
ID 097-00072

Expiration Date N/A

Date Issued JULY 27, 1994

Issued by Paul Dubenetzky
Commissioner

State Form 37080 R

Eli Lilly and Company
Indianapolis, Indiana

CP 097-3341
Plt ID 097-00072
Review Engineer: T.P.Sinha

NEW EQUIPMENT:

Unit ID	Unit Description	Location: Wing/Module
	Vacuum Shelf Dryer	D/E
	Vacuum Shelf Dryer	D/E
	Agitated Filter/Dryer	Portable
	PSE Catch Tank	D/E
	CIP System	Portable
	Mill	Portable
	Blender	Portable
	Floor Collection Tank	D/E&F
	500 Gallons Glass Lined Reactor	D/F
	300 Gallons Glass Lined Reactor	D/F
	200 Gallons Hastelloy Reactor	D/F
	100 Gallons Hastelloy Reactor	D/F
	100 Gallons Glass Lined Removable Reactor	D/F
	100 Gallons Glass Lined Removable Reactor	D/F
	Vacuum Shelf Dryer	D/F
	Vacuum Shelf Dryer	D/F
	Agitated Filter/Dryer	Portable
	PSE Catch Tank	D/F
	CIP System	Portable
	50 Gallons Hastelloy Reactor	D/30 Gal-A
	50 Gallons Hastelloy Reactor	D/30 Gal-B
	30 Gallons Glass Lined Reactor	D/Gal-B
	16" Single Plate Filter(Hastelloy)	Portable
	16" Single Plate Filter(Hastelloy)	Portable
	13 Gallons Evaporator	D/30 Gal-A
	50 Gallons Hastelloy Reactor	C/Portable
	50 Gallons Hastelloy Reactor	C/Portable
	50 Gallons Hastelloy Reactor	C/Portable
	50 Gallons Glass Lined Reactor	C/Portable
	50 Gallons Glass Lined Reactor	C/Portable
	50 Gallons Glass Lined Reactor	C/Portable
	30 Gallons Hastelloy Reactor	C/Portable
	30 Gallons Hastelloy Reactor	C/Portable
	30 Gallons Hastelloy Reactor	C/Portable
	30 Gallons Glass Lined Reactor	C/Portable
	30 Gallons Glass Lined Reactor	C/Portable
	30 Gallons Glass Lined Reactor	C/Portable
	5 Gallons Hastelloy Reactor	C/Portable
	5 Gallons Hastelloy Reactor	C/Portable

Eli Lilly and Company
Indianapolis, Indiana

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NEW EQUIPMENT:

Unit ID	Unit Description	Location: Wing/Module
	5 Gallons Hastelloy Reactor	C/Portable
	5 Gallons Glass Lined Reactor	C/Portable
	5 Gallons Glass Lined Reactor	C/Portable
	5 Gallons Glass Lined Reactor	C/Portable
	Vacuum Shelf Dryer	C/Portable
	Vacuum Shelf Dryer	C/Portable
	Vacuum Shelf Dryer	C/Portable
	Vacuum Shelf Dryer	C/Portable
	Vacuum Shelf Dryer	C/Portable
	Vacuum Shelf Dryer	C/Portable
	Rotary Vacuum Dryer	C/Portable
	Centrifuge	C/Portable
	16" Single Plate Filter (Hastelloy)	Portable
	16" Single Plate Filter (Hastelloy)	Portable
	16" Single Plate Filter (Hastelloy)	Portable
	16" Single Plate Filter (Hastelloy)	Portable
	Agitated Filter/Dryer	Portable
	Unit 93 Syltherm Cooling System	C-Wing
	Walk-in hood	E
	Walk-in hood	E
	Walk-in hood	E
	Walk-in hood	E
	Walk-in hood	E
	Walk-in hood	E
	Walk-in hood	F
	Walk-in hood	F
	Walk-in hood	F
	Walk-in hood	F
	Walk-in hood	F
	Walk-in hood	F

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EXISTING EQUIPMENT:

Unit ID	Unit Description	Location: Wing/Module
T-11	100 Gallons. Hastelloy Reactor	D/A
T-12	100 Gallons Stainless Reactor	D/A
T-13	200 Gallons Glass Lined Reactor	D/A
T-14	200 Gallons. Hastelloy Reactor	D/A
T-15	100 Gallons. Glass Lined Reactor	D/A
T-16	300 Gallons. Glass Lined Reactor	D/A
T-21	50 Gallons Glass Lined Reactor	D/B
T-22	100 Gallons Glass Lined Reactor	D/B
T-23	100 Gallons Stainless Reactor	D/B
T-24	50 Gallons Glass Lined Reactor	D/B
T-25	200 Gallons Glass Lined Reactor	D/B
T-26	200 Gallons Glass Lined Reactor	D/B
T-31	50 Gallons Stainless SteelReactor	D/C
T-32	100 Gallons Glass Lined Reactor	D/C
T-33	100 Gallons Glass Lined Reactor	D/C
T-34	100 Gallons Stainless SteelReactor	D/C
T-35	200 Gallons Stainless SteelReactor	D/C
T-36	200 Gallons Glass Lined Reactor	D/C

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EXISTING EQUIPMENT:

Unit ID	Unit Description	Location: Wing/Module
T-41	200 Gallons Glass Lined Reactor	D/D
T-42	100 Gallons Glass Lined Reactor	D/D
T-43	300 Gallons Glass Lined Reactor	D/D
T-44	200 Gallons Glass Lined Reactor	D/D
T-45	300 Gallons Glass Lined Reactor	D/D
T-46	300 Gallons Glass Lined Reactor	D/D
T-61	30 Gallons Glass Lined Reactor	D/30 Gal-A
T-62	30 Gallons Glass Lined Reactor	D/30 Gal-A
T-63	30 Gallons Glass Lined Reactor	D/30 Gal-B
VSD181	Vacuum Shelf Dryer	D/A
TDU182	Air Tray Dryer	D/A
TDU183	Air Tray Dryer	D/A
VSD281	Vacuum Shelf Dryer	D/B
TDU282	Air Tray Dryer	D/B
TDU283	Air Tray Dryer	D/B
VSD381	Vacuum Shelf Dryer	D/C
TDU382	Air Tray Dryer	D/C
TDU383	Air Tray Dryer	D/C
VSD481	Vacuum Shelf Dryer	D/D
TDU482	Air Tray Dryer	D/D
TDU483	Air Tray Dryer	D/D
VSD686	Vacuum Shelf Dryer	D/30 Gal-B
VSD696	Vacuum Shelf Dryer	D/30 Gal-A
VSD781	Vacuum Shelf Dryer	Solids Cont.
FH1	24" Single Plate Filter (S.S)	Portable
FH2	36" Single Plate Filter (S.S)	Portable
FH3	36" Single Plate Filter (S.S)	Portable
FH4	36" Single Plate Filter (Hastelloy)	Portable
FH6	24"Single Plate Filter(Glass Lined)	Portable
FH7	24" Single Plate Filter (Hastelloy)	Portable
FH8	36" Single Plate Filter (S.S)	Portable
FH9	24" Single Plate Filter (S.S)	Portable
FH10	36" Single Plate Filter (Hastelloy)	Portable
FH11	36" Single Plate Filter (Hastelloy)	Portable
FH12	16" Single Plate Filter (Hastelloy)	Portable
FH13	30" AgitatedFilter/Dryer(Hastelloy)	Portable
FH14	24" Single Plate Filter (Hastelloy)	Portable
FH16	16" Single Plate Filter (Hastelloy)	Portable
FS21	8" Multi-Plate Filter (S.S)	Portable
FS22	12" Multi-Plate Filter (S.S)	Portable
FS23	18" Multi-Plate Filter (S.S)	Portable
FS24	18" Multi-Plate Filter (Hastelloy)	Portable
FS25	18" Multi-Plate Filter (S.S)	Portable

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EXISTING EQUIPMENT:

Unit ID	Unit Description	Location: Wing/Module
FS26	8" Multi-Plate Filter (S.S)	Portable
FS27	8" Multi-Plate Filter (Hastelloy)	Portable
FS28	12" Multi-Plate Filter (Hastelloy)	Portable
FS29	18" Multi-Plate Filter (Hastelloy)	Portable
RC83	Distillate Receivers	Portable
GR82	Fitzmill Grinder	
GR86	Fitzmill Grinder	
GR87	Quatro Mill	
VBD500	Plow Blender	
PC991	Petchrom Column	D/High Bay
PC993	Distillation Column	C/
LTB99	Low Temp. Bath	Portable
	Acetone System - 4000 gallon acetone storage tank	
	Waste Solvent System - 7,500 gallon waste solvent tank	
	MAce Cooling System	C/
	Dowtherm J System	D/
PF9093	8 gal TFE-lined can (S.S)	Portable
PF9094	8 gal TFE-lined can (S.S)	Portable
PG40	40 L Glass-lined tank	Portable
PG41	40 L Glass-lined tank	Portable
PG 44	110 L Glass-lined tank	Portable
PG 45	110 L Glass-lined tank	Portable
PG 46	110 L Glass-lined tank	Portable
PG 47	120 L Glass-lined tank	Portable
PG 48	180 L Glass-lined tank	Portable
PG 49	180 L Glass-lined tank	Portable
PG 50	180 L Glass-lined tank	Portable
PG 51	110 L Glass-lined tank	Portable
PG 52	110 L Glass-lined tank	Portable
PG 9024	15 gal Glass-lined tank	Portable
PG 9025	15 gal Glass-lined tank	Portable
PG 9026	15 gal Glass-lined tank	Portable
PG 9027	15 gal Glass-lined tank	Portable
PG 9028	50 gal Glass-lined tank	Portable
PG 9029	50 gal Glass-lined tank	Portable
PG 9081	5 gal Glass-lined tank	Portable
PG 9082	75 gal Glass-lined tank	Portable

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EXISTING EQUIPMENT:

Unit ID	Unit Description	Location: Wing/Module
PH 9114	8 gal Hastelloy C Can	Portable
PH 9115	8 gal Hastelloy C Can	Portable
PH 9116	8 gal Hastelloy C Can	Portable
PH 9117	8 gal Hastelloy C Can	Portable
PH 9118	8 gal Hastelloy C Can	Portable
PH 9119	8 gal Hastelloy C Can	Portable
PH 9120	8 gal Hastelloy C Can	Portable
PH 9121	8 gal Hastelloy C Can	Portable
PS 70	180 L tank (S.S)	Portable
PS 9001	13 gal tank (S.S)	Portable
PS 9002	62 gal tank (S.S)	Portable
PS 9003	62 gal tank (S.S)	Portable
PS 9004	62 gal tank (S.S)	Portable
PS 9005	62 gal tank (S.S)	Portable
PS 9006	62 gal tank (S.S)	Portable
PS 9007	62 gal tank (S.S)	Portable
PS 9008	62 gal tank (S.S)	Portable
PS 9009	62 gal tank (S.S)	Portable
PS 9010	55 gal tank (S.S)	Portable
PS 9011	55 gal tank (S.S)	Portable
PS 9012	55 gal tank (S.S)	Portable
PS 9013	55 gal tank (S.S)	Portable
PS 9014	55 gal tank (S.S)	Portable
PS 9015	55 gal tank (S.S)	Portable
PS 9016	55 gal tank (S.S)	Portable
PS 9017	55 gal tank (S.S)	Portable
PS 9018	55 gal tank (S.S)	Portable
PS 9019	55 gal tank (S.S)	Portable
PS 9030	55 gal tank (S.S)	Portable
PS 9039	8 gal tank (S.S)	Portable
PS 9041	8 gal tank (S.S)	Portable
PS 9042	8 gal tank (S.S)	Portable
PS 9046	5.2 gal tank (S.S)	Portable
PS 9049	8 gal tank (S.S)	Portable
PS 9050	8 gal tank (S.S)	Portable
PS 9052	8 gal tank (S.S)	Portable
PS 9065	55 gal tank (S.S)	Portable
PS 9066	55 gal tank (S.S)	Portable
PS 9073	5 gal tank (S.S)	Portable
PS 9074	12 gal tank (S.S)	Portable
PS 9075	12 gal tank (S.S)	Portable
PS 9079	16 gal tank (S.S)	Portable

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EXISTING EQUIPMENT:

Unit ID	Unit Description	Location: Wing/Module
PS 9080	5 gal tank (S.S)	Portable
PS 9087	20 gal tank (S.S)	Portable
PS 9088	5 gal tank (S.S)	Portable
FH 112A	Walk-in hood	SCM Process
FH 112B	Walk-in hood	SCM Cleanup
FH 53A	Walk-in hood	30 gal A/1
FH 53B	Walk-in hood	30 gal A/2
FH 54A	Walk-in hood	30 gal B/1
FH 54B	Walk-in hood	30 gal B/2
FH 55A	Walk-in hood	D/1
FH 55B	Walk-in hood	D/2
FH 55C	Walk-in hood	D/3
FH 56A	Walk-in hood	B/1
FH 56B	Walk-in hood	B/2
FH 56C	Walk-in hood	B/3
FH 57A	Walk-in hood	A/1
FH 57B	Walk-in hood	A/2
FH 57C	Walk-in hood	A/3
FH 58A	Walk-in hood	C/1
FH 58B	Walk-in hood	C/2
FH 58C	Walk-in hood	C/3
FH 72	Walk-in hood	Clean-up room
FH 106	Walk-in hood	C-Wing

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Construction Conditions

1. That the data and information supplied with the application shall be considered part of this permit. Prior to any proposed change in construction which may affect potential emissions, this change must be approved by the Office of Air Management (OAM).

2. That this permit to construct does not relieve the permittee of the responsibility to comply with the provisions of the Indiana Department of Environmental Management Law (IC 13-7), Air Pollution Control Law (IC 13-1-1) and the rules promulgated thereunder, as well as other applicable local, state, and federal requirements.

3. That the equipment shall be installed in accordance with the manufacturer's specifications, and as stated in the application.

4. That pursuant to 326 IAC 2-1-9(b) the commissioner may revoke this permit if construction is not commenced within eighteen (18) months after receipt of this approval or if construction is discontinued for a period of one (1) year or more.

5. That pursuant to Indianapolis Air Pollution Control Board Regulation IX-1, this Construction Permit shall serve as a temporary operating permit until such time as a valid operating permit is either issued or denied by the Indianapolis Air Pollution Section (IAPCS), provided:

   a) Lilly submits written notification to the IAPCS of the anticipated initial start-up date of the new facilities not more than sixty nor less than thirty days prior to such date;

   b) Lilly submits written notification to the IAPCS of the actual initial start-up date of the new facilities within fifteen days after such date: and

   c) Lilly submits an application for an operating permit to the IAPCS within 180 days after operation of all the new facilities constructed under this permit.

   The operation permit issued by the IAPCS shall contain as minimum the conditions in the operation conditions of this permit.

6. That when the facility is constructed and placed into operation the following operation conditions shall be met:

Eli Lilly and Company
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Operation Conditions

1. That the data and information supplied in the application shall be considered part of this permit. Prior to <u>any</u> change in the operation which may result in an increase in potential emissions exceeding those specified in 326 IAC 2-1-1, this change must be approved by the Office of Air Management (OAM).

2. That the permittee shall comply with the provisions of the Indiana Environmental Management Law (IC 13-7), Air Pollution Control Law (IC 13-1-1) and the rules promulgated thereunder.

3. That the equipment shall be operated and maintained in accordance with the manufacturer's specifications.

4. That pursuant to 326 IAC 8-1-5 and 326 IAC 8-5-3 the following shall be met:

   a) volatile organic compound (VOC) emissions from pilot plant in Building 110 shall be limited to 19.01 tons/year based on a twelve month average rolled on a monthly basis.

   b) volatile organic compound (VOC) emissions from each facility covered under 326 IAC 8-1-5 shall be limited to 15 pounds per day/33 pounds per day based on calender month average.

   For purposes of determining compliance with the daily emission limit for each facility, Lilly may calculate emissions using the following methods:

   1. Using monthly mass balance data for each module to prorate a portion of the total emissions from the module to each facility.

   2. Calculating emissions from solvent and waste solvent storage tanks using equations in section 4.3 of AP-42.

   3. When a portable emitting facility operates independently of any stationary emitting facility and vents emissions separately from any stationary emitting facility, then the emissions from that portable facility shall be attributed to that portable facility. When a portable emitting facility is connected to and operates in conjunction with any stationary emitting facility and the emissions from portable facility are vented with the emissions from the stationary facility, the emissions from the portable facility shall be attributed to the stationary facility.

   c) the primary reactor condensers will operate during reactor venting, material transfer, distillation, and storage of filtrates in reactors which are transferred from the filters. The primary reactor condensers working fluid inlet temperature will be - 10 degrees C or colder for mixtures that will not freeze at - 10 degrees C (includes most non-aqueous streams).

d) the working fluid temperature at the inlet and outlet of the primary reactor condensers shall be recorded while the condensers are in operation.

e) any startup, shutdown, or malfunction period causing excessive emissions shall be recorded. The records shall include the start time, end time, and the estimated quantity of excess emissions emitted during the occurrence.

5. That a log of information necessary to document compliance with condition no.4, shall be maintained. These records shall be kept for at least the past 24 month period and made available upon request to the Office of Air Management. A quarterly summary shall be submitted to:

Environmental Resources Management Division
Air Pollution Control Section
Enforcement Branch, Enforcement Manager
2700 South Belmont Avenue
Indianapolis, Indiana 46221

within 60 days after the end of the quarter. The volatile organic compounds (VOC) emissions shall be reported in the format attached.

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Indianapolis Air Pollution Control Section

Quarterly Solvent Usage Report

Eli Lilly and Company — Facility I.D. : Pilot plant

Indianapolis, Indiana — Construction Permit No. : CP 097-3341

Pollutant: VOC — Plt ID No.: 097-00072

Limit (tons per 12 month period) : 19.01 tons

Monthly Emission Data

Year: __________

Month	No. of Batches Processed	Tons VOC Emitted this Month*	Tons VOC Emitted in Last 12 Months

* Production records which complies with this emission limits should be recorded and submitted with report.

Submitted By: ______________________

Date Submitted: ______________________

Eli Lilly and Company
Indianapolis, Indiana

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Review Engineer: T.P.Sinha

Indianapolis Air Pollution Control Section

Quarterly Solvent Usage Report

Eli Lilly and Company — Pilot plant/Building 110

Indianapolis, Indiana — Construction Permit No. : CP 097-3341

Pollutant: VOC — Plt ID. : ID 097-00072

Limit (Daily Average) : 15 lbs/day or 33 lbs/day

Year : ______

Facility ID	Month ______ (lb/day)	Month ______ (lb/day)	Month ______ (lb/day)

Notes:

1. Production records which complies with this emission limits should be recorded and submitted with report.

2. Average daily VOC emissions should be calculated using monthly mass balance information and CTG equations apportioned to individual facilities and averaged over the month.

Submitted By: ______________________

Date Submitted: ____________________

Mail to: Indianapolis Air Pollution Control Section
Enforcement Branch, Enforcement Manager
2700 South Belmont Avenue
Indianapolis, Indiana 46221

Eli Lilly and Company
1555 S.Kentucky Avenue
Indianapolis, Indiana

Affidavit of Construction

I hereby certify that Eli Lilly and Company has constructed the two modules E and F, and several portable equipment associated with the pilot plant in Building 110 in accordance with the intent of the construction permit application submitted to the Office of Air Management, Indiana Department of Environmental Management, Indianapolis, Indiana on October 27, 1993 and as permitted pursuant to Construction Permit No. 097-3341, Plt ID No. 097-00072 issued on____________________.

____
signature

____
name and title (typed or printed)

____
date

Supplement to original submittal to EPA for SIP change

Eli Lilly and Company
Indianapolis, Indiana

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Review Engineer: Dr. T.P.Sinha

ECONOMIC ANALYSIS

PART I

Economic Feasibility
for Control Technologies
for Modules A to D
in Building 110

1A. Condensation Control Technology

HAP heat content:	17,000 Btu/lb	
Molecular weight of HAP, Mwhap:	70.87	
Emission Stream Flow, Qea:	10.0 acfm	
Emission Stream Flow, Qe:	10.0 scfm	
Stream Pressure, P:	1 atm	
Stream Temperature, Te:	77^0F	
Air Pollution, HAP:	VOC	
Maximum HAP conc., HAPe:	185034 ppmv	
Removal efficiency, RE:	96.3%	
Heat Transfer Coefficient, U:	20.0 Btu/hr-ft^2-^{0}F	
System Pressure Drop, P:	5.0 inches	
Temperature for 1 mm Hg vapor pressure	-54.6^{0}F	
Temperature for 100 mm Hg vapor pressure	67.9^{0}F	
Operating hours/year, HRS:	2,560 hours	
Heat exchanger efficiency, HR:	95%	
System pressure drop, Psys:	5.0 inches	
Coolant pump motor efficiency, n:	0.65	
Peak/Average Flow Ratio:	1.0 scfm/scfm	
Minimum coolant velocity:	3.0 ft/sec	
Coolant tube diameter:	0.375 inches	
Coolant specific heat:	0.65 Btu/lb-^{0}F	
Coolant specific gravity, Sg:	7.48 lb/gal	
Coolant liquid cost, US$cool:	$7.6/gal	From vendor
Auxiliary equipment cost, AEC: (Fan, ductwork, stack, & damper)	$99,500	
Cost of Building, Bldg:	$0.0	
Cost of site preparation, SP:	$0.0	
Electricity cost, U$elect:	$0.059/kwh	From Table 4.6-7, *358.6/340.1

Operating labor cost:	\$30.o/hr	From Table 4.3-6, *358.6/340.1
Maintenance labor cost:	\$30.o/hr	From Table 4.3-6, *358.6/340.1
Refrigerator efficiency, Ef:	65 percent	

Calculate Ppartial pressure of HAP in outlet stream:

$P_{partial}$ = 760 * (1-0.01RE)/(1-RE*1.0E-08*HAPe)*HAPe*1.0E-06
= 6.33 mmHg

Condensation Curve X_{int},

X_{int} = $1/(X_{int} + 460)$
= 0.00247 (1/Deg R)

Condensation curve slope,

CSI = $-(1/(T_{con\ 100mm\ Hg} + 460)) + Xint/2$
= 0.00029 ^{0}R mm Hg

Calculate T_{con} = $1/[(X_{int}$ -CSI*LOG(P_{vapor}))-460]

(-25.04 ^{0}F) = -13.1^{0}F

Composition of Coolant: DOWTHERM
IF T_{con} >60, WATER
IF 45 < Tcon > 60, CHILLED WATER
IF -30 < T_{con} > 45, DOWTHERM
IF Tcon < -30, FREON.

Moles HAP in inlet emission stream/min, HAPem = Qe/392 * HAPe * 1.0E-06
= 0.00472 lb-moles/min

Moles HAP in in outlet emission stream/min, HAPem = Qe/392 * (1- HAPe * 1.0E-06) * P_{vapor} / (Pe-P_{vapor})
= 0.00017 lb-moles/min

Moles HAP condensed/min, HAP_{con} = HAP_{em} - HAP_{om}
= 0.00455 lb-moles/min

Heat of vaporization at T_{con}, dH	= 709 Btu/lb-mole
HAP avg', spec. heat for temp Tcon to Te, CP_{hap}	= 10.84 Btu/ lb-mole-^{0}F
Enthalpy change of condensed HAP	= HAP_{con} [dH + CP_{hap}*(Te - Tcon)] = 7.66 Btu
Enthalpy change of air, $H_{noncond}$	=[(Qe/392) - HAP_{em}] CP_{air} (Te -T_{con})] = 13.20 Btu
Condenser heat load	= 1.1 * 60 * (H_{con} + H_{noncon}) = 1377 Btu/hr
Coolant input temperature, T_{cooli}	= T_{con} - 15 = -28.1^{0}F
Coolant output temperature, T_{coolo}	= T_{cooli} + 25 = -3.1^{0}F
Log mean temperature difference, DT_{lm}	= (Te - T_{coolo} -15)/LN ((Te - T_{coolo})/15) = 38.9^{0}F
Area of condenser, A_{con}	= H_{load} * (PkFlow/AvgFlow)/(U*DTlm) = 1.77 ft^2
Average specific heat of coolant, $CP_{coolant}$	= 0.65 Btu/lb-^{0}F
Coolant flow rate, Q_{cool}	= MAX(H_{load} /($CP_{coolant}$(T_{coolo} - T_{cooli}), F_{min} * * Td^2 *D_{ens} * 7.48 gal/ft^3 * 3 * 3600 sec/hr)

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= 590 lb/hr

Total coolant required, Qc_{tot} = 200 gal (Estimated)

Refrigeration capacity, Ref = H_{load} * (PkFlow/AvgFlow)/12000
= 0.11 tons

Recovered product, Q_{rec} = 60 * HAP^{con} * Mw_{hap}
= 19.33 lb/hr

<u>CAPITAL COSTS</u>

<u>DIRECT COSTS</u>

<u>Purchased equipment costs</u>

Refrigeration Capital Cost, RCC	= $28,919	From Table 4.8-4, corrected to April, 1992 dollars
Condenser Capital Cost, CCC	= $5,836	From Figure 4.8-3, corrected to April, 1992 dollars
Auxiliary Equipment Cost, AEC	= $99,500	Parameter
Cost of Cooling Liquid, T$cool	= $1,520	Qc_{tot} * U$cool

Total Equipment Cost, A = $ (RCC + CCC + AEC)
= $135,775

Instrumentation Cost, I = 0.10 * A
= $13,577

Sales Taxes, S = 0.05 A
= $6,789

Freight, F = 0.05 * A

= $6,789

Purchased Equipment Costs, B = $ (A + I + S + F)
= $ 162,930

Direct Installation Costs

Foundation and Supports = 0.08B
= $13,034

Handling and Erection = 0.14B
= $22,810

Electrical = 0.08B
= $13,034

Piping = 0.02B
= $3,259

Insulation for ductwork = 0.10B
= $16,293

Painting = 0.01B
= $1,629

Direct Installation Costs, C = (Foundation and Supports + Handling and Erection + Electrical + Piping + Insulation + Painting) Costs
= $70,060

Site Preparation, D = $0

Building Cost, E = $0

TOTAL DIRECT COSTS= $(B + C + D + E)
= $232,990

INDIRECT COSTS (INSTALLATION)

Engineering = 0.10 B

= $116,293

Construction and field expense = 0.05 B = $8,146

Contractor Fees = 0.10 B = $16,293

Start-Up = 0.02 B = $3,259

Performance Test = 0.01 B = $1,629

Contingencies = 0.03 B = $4,888

TOTAL INDIRECT COSTS = (Engineering + Construction + Contractor Fees + Start-Up + Performance Test + Contingencies) costs
= $ 50,508

TOTAL CAPITAL INVESTMENT (TCI) = (TOTAL DIRECT COSTS + TOTAL INDIRECT COSTS)
= $(232,990 + 50,508)
= $ 283,498

DIRECT ANNUAL COSTS

System Pressure Drop, P_{sys}	= 5 inches	Parameter
Fan power requirement, F_p	= 23 kwh/yr	1.81E-04*Qea*P*HRS
Refrigeration power requirement, R_p	= 1588.88 kwh/yr	H_{load} * HRS * 2.9E-04 kwh/btu/Er
Coolant pumping requirement, P_p	= 245.32 kwh/yr	[2.52 E-04 * Qcool/60/Sg * H * Sg/7.48/n] * HRS *0.748 From Table 4.6-8 of HAP manual

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Plt. ID 097-00072
Review Engineer: Dr. T.P.Sinha

Annual
electricity cost = $110 U$elec * (Fp + Rp + Pp)

Cost of Refrigerant= $0

<u>Operating costs</u>

(a) Operating labor
costs = $4,800 [(0.5 hr/shift)/(8 hr/shift)] *(HRS)* ($hourly rate)

(b) Supervisory
Costs = $720 0.15*(Operating labor costs)

Operating costs = $(4,800 + 720)
= $ 5,520

<u>Maintenance cost</u>

(a) Maintenance
labor costs = $4,800 [(0.5 hr/shift)/(8 hr/shift)] * (HRS)* ($hourly rate)

(b) Maintenace
materials = $4,800 1.0 *(Maintenance labor costs)

Maintenance costs = $(4,800 + 4,800)
= $ 9,600

Disposal of
recovered HAP = $129 V_{hap} * ER * 2000 * RE

TOTAL DIRECT
ANNUAL COSTS = (Electricity + Refrigerant + Operating + Maintenance + Disposal of recovered HAP) Costs
= $15,359

<u>INDIRECT ANNUAL COSTS</u>

Overhead = 0.60 (Operating + Maintenance)
= $9,072

Property Tax = 1 percent of TCI
= $2,835

Insurance	= 1 percent of TCI = $2,835
Administrative	= 1 percent of TCI = $5,670
Capital Recovery	= CRF * TCI = $46,138
Total Indirect costs	= (Overhead + Property Tax + Insurance + Administrative + Capital Recovery) Costs = $66,550
TOTAL ANNUAL COSTS	= TOTAL INDIRECT ANNUAL COSTS + TOTAL DIRECT ANNUAL COSTS = $(66,550 + 15,359) = $ 81,909

1B. Absorption Control Technology

Average flow rate, Q_{avg}	= 10 scfm
Maximum flow rate, Q_e	= 10 scfm
Temperature, T_e	= 77^0F
HAP	= VOC
HAP concentration, HAPe	= 185034 ppmv
Pressure, Pe	= 760 mm Hg
Removal efficiency, RE	= 58.8%
Mol. wt. of emission stream, Mwe	= 70.87 lb/lb-mol

Solvent used		= Water	
Slope of equilibrium curve,	m	= 2.64	from Perry's Handbook Figure 14-14
Mol. Wt. of solvent,	Mw_{sol}	= 18 lb/lb-mol	
Disposal cost of solvent,	Dsc	= $266/1,000 gals	
Schmidt # in gas,	Scg	= 1.24	
Schmidt # in liquid,	S_{cl}	= 804 $U_1/(P_1*D_1)$	
Solvent density,	D_1	= 62.18 lb/ft^3	
Solvent Viscosity,	U_1	= 0.815 cp	Weast Pg. F-42
Absorption factor,	AF	= 1.6	from HAP manual example case
Packing constant,	A	= 28	
Packing constant,	e	= 0.74	
Fraction of Flooding V.,	f	= 0.6	
Packing constant,	b	= 3.82	
Packing constant,	c	= 0.41	
Packing constant,	d	= 0.45	

Packing constant, Y	= 0.0125	
Packing constant, s	= 0.22	
Packing constant, g	= 11.13	
Packing constant, r	= 0.00295	
Bed type	= Single	
Packing material cost, P_{cost}	= \$12.75/ft^3	
Hours/yr	= 2560	
Electrical cost	= \$0.059/kwh	
Water cost	= \$0.20/1,000 gals	
Operating labor cost	= \$30/hr	
Maintenance labor cost	= \$30/hr	

CALCULATIONS

Gas stream flow rate	= 1.55 lb-mol/hr	0.155*Qe
Liquid flow rate, L_{mol}	= 6.5472 lb-mol/hr	AF * m * Gmol
Liquid flow rate, L_{gal}	= 0.24 gal/min	[Lmol * Mwsol * (1/Dl)* 7.48]/60
Solvent flow rate, L	= 118 lb/hr	Mwsol * Lmol